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ABSTRACT

As foreign control has grown during the early stages of Canadian technology, one of the major issues of concern to Canadians has become: How does a country with a relatively small population and limited capital shift its emphasis from natural resource development to development of secondary industry without surrendering even a greater degree of control to foreign countries? The influence of other countries is evident in the Canadian university, where academic staffs have a high proportion of noncitizens. Approximately one fifth of the country's basic research, which is the predecessor of advanced technology, is done in a handful of institutions, and those that have achieved status as major research universities have done so by making deliberate priority decisions to hire research-oriented faculty and by giving them the freedom to pursue their interests. Developing and developed countries must squarely face this issue: if a country desires good research, it is not sufficient to create and fund large universities; on that basis alone, a university oriented toward serving large numbers of undergraduate students may well emerge, and research and technology are not well served. By reducing the amount of research support for universities, Canada may be hindering one of its most positive forces for the advancement of an indigenous technology. (Author/MSE)

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THE RELATIONSHIP BETWEEN HIGHER EDUCATION AND TECHNOLOGICAL DEVELOPMENT: THE CANADIAN EXPERIENCE

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THE RELATIONSHIP BETWEEN HIGHER EDUCATION AND TECHNOLOGICAL DEVELOPMENT: THE CANADIAN EXPERIENCE

The relationship between higher education and technological development is of interest to educators and government policy makers throughout the world, particularly in developing and developed countries. This paper describes that relationship in Canada, from its historical roots to its present structure. The paper is divided into three major sections: (1) the development of Canadian technology; (2) the emergence and current status of Canadian higher education; and (3) the interface between technological development resulting from higher education and the application of this technology in the nation. As a preface to the first major section, the following section contains background information on Canada.

A Bit of Background[1]

Canada is a paradox. It covers approximately 7% of the world's land area (second largest country in the world), but has only one-half of 1% of the world's population. Its population per square mile is about one-fifth that of Brazil, and only one-tenth that of the United States. Canada has only nine cities with populations of 500,000 or more, the largest of which (Montreal and Toronto) are approximately one-fourth the size of Sao Paulo. Canada's paucity of people is offset by its riches of agricultural and natural resources. It is one of the world's leading producers of grain, forest products,

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[1]Data in this section were taken from:
G.E. Delury, ed., The World Almanac and Book of Facts 1976 (United States: Newspaper Enterprise Association, Inc., 1975).
C.J. Harris, ed., The Canadian Pocket Encyclopedia (30th Annual Edition; Toronto, Ontario: Quick Canadian Facts Ltd., 1975).
Guillermo de Zéndegui, ed., Image of Brazil (Washington, D.C.: Organization of American States, 1976).
Brazil: Challenge and Progress (London, England: The Brazilian Embassy, 1975).

and fertilizers. It is rich in mineral deposits (coal, iron, copper, uranium, etc.), water resources, and arable land. The country has the great range of natural resources that is required to achieve major status among the world's leading nations.

In 1974, Canada's total exports were valued at $31 billion, 60% of which was in manufactured products. Of this 60% ($18 billion), $5.5 billion was in automotive products--an industry which is almost totally owned and controlled by United States based multi-national corporations. The auto industry in Canada is essentially a chunk of Detroit that has been moved across the border (the bulk of Canada's auto industry lies within a 400 miles radius of Detroit). As such, it retains the stature of a United States' branch plant. If auto exports were removed from the calculations, only approximately 50% of Canada's exports were in manufactured products. The remainder came from Canada's wealth of natural resources. Brazil presently ranked just behind Canada in the proportion of its exports in manufactured products.

An overview of these factors--a vast, relatively unpopulated country, rich in natural resources, whose exports are based primarily on natural resources rather than on manufactured goods--might lead one to classify Canada as underdeveloped or at least in the early stages of development. However, the coin has another face.

Canada has the fifth-highest Gross National Product (G.N.P.) per capita in the world, following the United States, Switzerland, Sweden, and West Germany in that order. The country has advanced systems of social benefits and health care. Unemployment is moderate and literacy and education rates are high. Canada spends approximately 8% of its G.N.P. on education. Transportation and communications are among the best in the world, and these services extend into the country's remote areas. On this side of the development coin, Canada is among the most developed countries in the world.

Canada is truly a paradox: on the one hand it is highly developed, on the other it can be considered underdeveloped. This paradox extends into the area of technology. For example, countries around the world look to Canada for leadership in nuclear power. At the same time, however, we import our hand-operated water pumps from Europe and the United States. We are very highly-developed in certain sectors of technology and rather backward in others. This point will be discussed in more detail in the section on the development of technology.

The historical basis for these paradoxes is close at hand. Culturally, Canada is the young son of old and sophisticated parents (England and Europe).. Geographically, it is huge, rugged, and diversified. Economically, industrially, and technologically it is the little brother of a giant (the United States). Over the years as the giant carved out his territory, the role of the little brother was molded for him.

Following from this brief introduction, the next section traces the development of the country's role in the area of technology. Appendix A contains data that may be useful in understanding Canada's economic and educational systems.

The Development of Canadian Technology

History of Industrialization

During the early years of Canada's history and up into the 20th century, the country's status as part of the British commonwealth and the attitude of its people toward foreign investment, coupled with the demographic factors discussed in the preceding section, laid a foundation for technological development that still remains. As a colony Canada began, as do colonies all over the world, to export raw materials and import manufactured goods. This trade arrangement did little to foster indigenous technology.

Coupled with this colonial scenario was a more or less conscious policy of encouraging maximum development of natural resources in response to demand.[2] This development demanded large amounts of capital which was not available within the country.[3] Early national leaders, such as Sir John A. Macdonald, Canada's first Prime Minister, felt that the best way for Canada to develop and simultaneously protect its national autonomy was to encourage heavy foreign investment in the natural resource sector and to protect the secondary industry sector through tariffs.[4] The role of secondary industry was conceived of as one which primarily served only the domestic market.

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[2]Jonn Fayerweather, Foreign Investment in Canada (Toronto, Ontario: Oxford University Press, 1974), p. 9.

[3]Canada's population did not exceed 10 million until 1931.

[4]Fayerweather, p. 9.

This situation remained relatively stable until the close of World War II. Following the war, Canada's population began to grow. Since its markets for manufactured goods were protected by tariffs, foreign companies moved into the country and established manufacturing operations. Chart 1 and Table 1 give an indication of the growth and current extent of foreign investment in the Canadian economy.

By 1960 foreign control of Canada's industry had stabilized and a definite pattern had emerged (see Table 2). Foreign control, primarily on the part of United States based multi-national corporations, was strong in mining and smelting, petroleum and natural gas, and manufacturing. Within the manufacturing sector this control was particularly strong in rubber products, the transportation industry, electrical apparatus, and chemicals (industries which require vast amounts of capital to develop). Thus, Canada entered the second half of the 20th century with a technology that was an integral part of a North American network of technology.

The Shape of Technology in 20th Century Canada

To say that foreign control had a great impact on Canadian technology would be an understatement. In many sectors of industry, technology was established as a "branch plant" operation. This situation had and continues to have advantages and disadvantages for the Canadian populace. Sophisticated technological developments were made readily available to Canadians with little investment of the country's fiscal and human capital.[5] Technology for everything from automobiles through computers, and radial tires to xerox machines, was imported. While the benefits of this technology went to the Canadian public, the determination of what technological benefits would be provided was made by the multi-national corporations. No doubt this low-cost, high-value technology had much to do with (1) the establishment of Canada as a developed country in spite of its small population and (2) the promotion of a high standard of living.

This situation spawned several issues: (1) the protection of the sectors of society vital to Canada's national identity, (2) the problem of moving from an economy based on exploitation of national resources to one based on manufacturing, and (3) the "Canadianization" of Canada's technology to a degree sufficient to ensure its role as a major world power. Each of these aspects is dealt with in turn in the following paragraphs.

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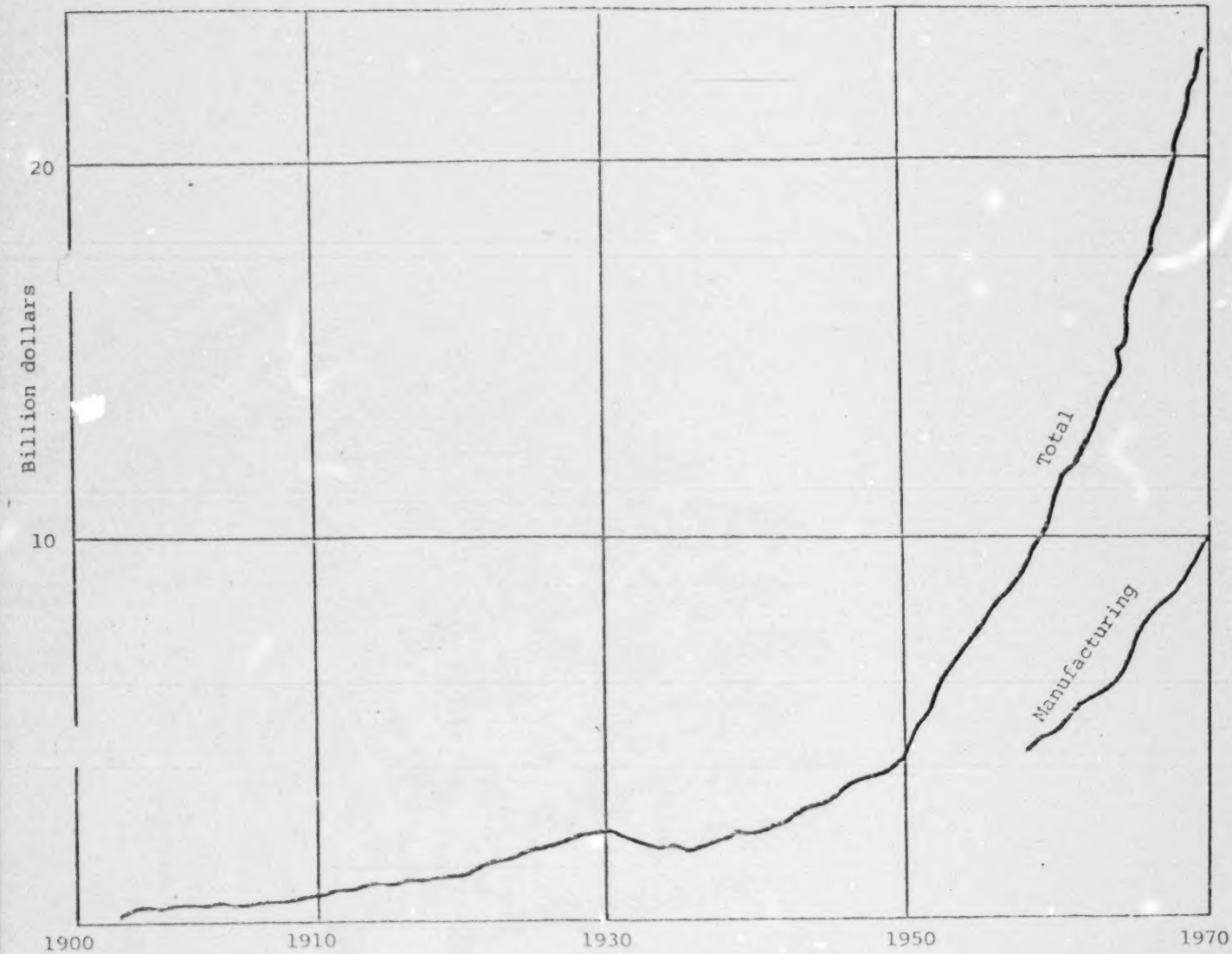
[5] In 1967 Canada spent 1.4% of its G.N.P. on research and development as opposed to 2.9% in the United States (see Fayerweather, p. 92).

CHART 1

U.S. DIRECT INVESTMENTS IN CANADA[6]



[6]Fayerweather, p. 5.

TABLE 1

DIRECT FOREIGN INVESTMENTS IN CANADA[7]
(BOOK VALUE IN BILLIONS OF DOLLARS)

	TOTAL		MANUFACTURING		PETROLEUM		MINING/ SMELTING	
	TOTAL	U.S.	TOTAL	U.S.	TOTAL	U.S.	TOTAL	U.S.
1930	$2.4	$2.0	$1.5	$1.2	$0.2	$0.1	$0.3	$0.2
1939	2.3	1.9	1.4	1.2	n.a.	n.a.	0.3	0.3
1946	2.8	2.4	1.9	1.6	0.2 (1945)	0.2 (1945)	0.4	0.3
1950	4.0	3.4	2.8	2.3	0.7 (1951)	0.7 (1951)	0.6	0.5
1954	6.8	5.8	3.9	3.1	1.5	1.4	1.1	0.9
1960	12.9	10.5	6.5	5.1	3.7	3.2	2.0	1.7
1963	15.5	12.8	7.4	6.0	4.8	4.0	2.3	2.0
1964	16.0	13.0	8.0	6.5	4.8	4.0	2.5	2.1
1965	17.4	14.9	8.8	7.3	5.2	4.2	2.6	2.2
1966	19.0	15.6	9.9	8.3	5.8	4.7	2.9	2.6
1967	20.7	17.0	10.6	9.0	6.0	4.9	3.4	2.9

TABLE 2

FOREIGN CONTROL AS A PERCENTAGE OF SELECTED CANADIAN INDUSTRIES, SELECTED YEARS, 1926-1963[8]

	PERCENT CONTROL						
	1926	1930	1939	1948	1954	1958	1963
Manufacturing	35	36	38	43	51	57	60
Petroleum and natural gas*					69	73	74
Mining and smelting	38	47	42	40	51	60	59
Railways	3	3	3	3	2	2	2
Other utilities	20	29	26	26	8	5	4
Total of above industries	17	20	21	25	28	32	34

* Petroleum and natural gas combined with mining and smelting for years 1926, 1930, 1939, and 1948.

FOREIGN CONTROL OF SELECTED CANADIAN MANUFACTURING INDUSTRIES, 1963
PERCENTAGE OF CAPITAL EMPLOYED CONTROLLED BY NON-RESIDENTS

MANUFACTURING	PERCENT
Beverages	17
Rubber	97
Textiles	20
Pulp and paper	47
Agricultural machinery	50
Automobiles and parts	97
Other transportation equipment	78
Primary iron and steel	14
Electrical apparatus	77
Chemicals	78
Other	70
TOTAL	60

[7] Fayerweather, p. 6.

[8] Fayerweather, p. 7.

Until recently the Americanization of Canadian culture proceeded with little evident public concern. The content of the media and performing arts--radio, T.V., film, theater, music, magazines, the press, etc.--was heavily impregnated with U.S. culture.[9] Education materials at all levels had heavy U.S. content, many of them were exactly the same as those used in U.S. schools, (eg., the Science Research Associates elementary school instructional materials). In addition, the academic staff of Canadian universities had a high proportion of non-citizens, many of whom were from the United Kingdom and the United States.

Within the past few years Canada has become increasingly concerned about the Americanization of its culture and has made attempts to protect its cultural identity by regulating U.S. content on Canadian radio and television, and by pressuring universities to refrain from recruiting faculty from the United States. The irony of this situation is that Canada is heavily dependent on the United States for the basic technology related to the media and to many of the "newer" academic disciplines. As we have seen, Canada's electronics industry, which is the technological backbone for the communications industry, is dominated by United States based companies. At the present time in the area of higher education, the only significant recruitment of new university faculty in those disciplines with a high technological content is in the newer technologies, eg. pollution abatement, more efficient transportation and communications, etc. Since the initial development of many of these areas begins in the United States, Canada may not be able to foster the basic research in its universities that it needs to become a major world power if it restricts the importation of human capital who are highly trained in the newer technologies. Thus, the protection of national identity has a price, and Canadians are already aware of this fact: "Per capita income is now 25 percent less in Canada than in the United States. Thus most Canadians are conscious that they already are paying a high price for independence."

How does a country with a relatively small population and limited capital shift its emphasis from natural resource development--with its related technology in metallurgy, mining, etc.--to development of secondary industry without surrendering even a greater degree of control of its industry to foreign-based companies? This is one of the major questions facing Canada at the present time. Canada has made some progress

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[9] Fayerweather, pp. 28-39.

[10] Fayerweather, p. 25.

in this regard by beginning to limit the export of natural resources to the United States (eg., natural gas)[11], and by concentrating efforts in the development of technologies in which the country has natural advantages--eg., nuclear power, cold climate systems, etc. However, the ability of the country to achieve a major shift in emphasis from natural resource exploitation to secondary industry over a relatively short time horizon is very uncertain.

The issue of "Canadianizing" Canada's technology to a degree sufficient to ensure its role as a major world power is in actuality an extension of the preceding discussion. In this regard, a number of questions need to be addressed.

(1) Do those companies which are strictly speaking "Canadian companies" direct enough fiscal resources and human energies toward technological development?

(2) Is government support of research and development (R & D) directed toward undertakings that promote Canada's international position?

(3) If Canada reacts negatively toward the "branch plant" approach to R & D in Canadian subsidiaries of United States multi-national corporations, will not opportunities for employment of highly-skilled Canadian manpower be restricted even further?

(4) How can truly "Canadian companies" attract fiscal capital from the Canadian economy when a large history of investment in United States corporations exists (Canadians have invested about $560 per capita in United States companies)[12]?

(5) Can Canadian firms bring their cost structures in line with those of companies in other major nations (especially those forming the European Common Market and the United States), in order to ensure effective international competition on the part of Canadian products?

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[11] Fayerweather, p. 88.

[12] Innovation in a Cold Climate (Ottawa, Ontario: Science Council of Canada, Report No. 15, 1971), p. 30.

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Canadians have begun to address these questions in a serious way only within the past decade and definitive answers are not yet at hand. However, some directions are emerging. The first is the idea of product specialization, mentioned earlier, in which Canada would carve out certain product niches in which it could be competitive on an international basis. In this regard some success has been achieved in the area of nuclear power. The second direction, one which is closely related to product specialization, is that of rationalization. This concept involves the assignment by multinational corporations of certain areas of technology to Canada and certain to the United States and the corresponding elimination of tariffs on both sides of the border for products in these areas. This concept has worked relatively well in the area of defense technology and the automotive industry. The third direction emerging in Canada's attempt to "Canadianize" the country's technology to an extent sufficient to ensure major international status relates to trade agreements. The country appears to be exploring areas in which it can develop such agreements.

The discussion in this section has been an attempt to tra e the factors, other than higher education, which have affected the development of Canada's technology. The next section will deal briefly with the development of higher education in Canada, with special emphasis on issues related to technology. The final section in the paper will deal with the interface between higher education and national technological development.

The Emergence and Current Status of Canadian Higher Education as It Relates to Technology

The modern North American university has one foot planted in the German research university of the 1800's (eg., Berlin), and one foot planted in the colonial colleges, which were direct descendants of the early British universities. As a contemporary force in the development of technology, the large United States universities (eg., Harvard University, the University of Michigan, the University of California at Berkeley, etc.) and the major technological schools (eg., Massachusetts Institute of Technology, California Tech., etc.) emerged early in the 20th century. In recent years many major United States universities and technical schools have become very heavily involved in the development of technology through basic and applied research. By 1969 the United States Federal Government granted over $2 billion to the

support of R & D in universities.[13] The vast majority of this support was for research in areas of high technology.

The emergence of Canadian universities followed that of the United States and did not occur to any large extent until after World War II. Prior to the war, probably only McGill (in Montreal, Que.), the University of Toronto, and the University of British Columbia could be regarded as major research universities. Since that time major research universities have emerged in each of the large metropolitan areas--see Appendix A, Table 10 and the map in Appendix B.

The diversity of the country has produced a corresponding diversity in its post-secondary educational institutions. The larger provinces (in terms of population) have a clearly articulated structure of technical schools, colleges of applied arts and technology (community colleges), institutes of technology, and universities. In these jurisdictions differentiation of roles has occurred not only by type of instruction, eg., community college vs. university--but within each type of institution. For example, some universities have emphasized research in the social sciences, some in the physical sciences, some in engineering, some in the health sciences, etc. This specialization, coupled with the mechanisms for financing university research (which will be discussed in the following section), the location of various universities, and the history of internal priority decisions in the universities, has resulted in a few universities gaining status as major research universities (in Canada, the universities are the only post-secondary education institutions performing any degree of basic or applied research). In the 1974-75 academic year, 14 of Canada's 59 universities received more than $3 million each in federal support for research. Thus, 76% of the $113.5 million in federal support for research was distributed to one-quarter of the institutions.[14] At the author's own university, over 21% of the institution's total operating budget of $63 million was in sponsored research.[15]

Since over 25% of the Canadian federal support for research goes to universities (the balance going to industry

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[13] R. Clarke "Sponsored Research and Universities," Sci Journal, V (January, 1969), pp. 81-86.

[14] Directory of Federally Supported Research in Universities (Vol. I, 1974-75, National Research Council of Canada).

[15] Committee of Finance Officers-Universities of Ontario, Total Revenue and Expenses for Provincially Assisted Universities of Ontario for the Fiscal Year Ended April 30, 1975 (Toronto, Ontario: Council of Ontario Universities, 1975).

and government agencies--see Appendix C, Table 1) and since 14 universities received 76% of the federal research funds going to all Canadian universities, one can draw the rough conclusion that approximately one-fifth of the country's basic research, which is the predecessor of advanced technology[16], is done in a handful of institutions. Thus, one can see that Canadian higher education has evolved to a place where a small number of major research universities have a high impact on the country's technological development.

Before moving into the next section which discusses the interface between the technological developments in these universities and the application of this technology in the nation, two points of clarification are in order. The first is the difference in definition between "sponsored" research in Canada and in the United States. In Canada, the term applies to free basic research initiated by a university researcher. In the United States the term often applies to mission-oriented or applied research negotiated between a university researcher (or the university as an organization), and a granting agency. The second point follows directly from the first. In Canada, most university research is initiated entirely by individuals (or groups) of faculty and the institution serves merely as provider of facilities and as bookkeeper. In the United States a considerable amount of research is negotiated between the university as a corporate entity (or a subsidiary of the university set-up specifically for research such as the Syracuse University Research Corporation, S.U.R.C.) and a granting agency.

The following section describes aspects of the interface between research (and its child, technology) in the university and its application in the nation.

The Interface Between Research in Universities and the Application in Society of the Resultant Technology

As was noted earlier, the implicit assumption in this paper is that technology results directly from the basic applied research cycle. That is, it is assumed that basic → research leads to applied research which leads to technology. This section proceeds directly from that assumption. Here we deal with dimensions of the interface between universities and the nation that are required to foster technological development--i.e., we discuss some of the factors that facilitate basic and applied research in universities.

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[16]This paper assumes throughout that technology is the direct descendant of basic research. This point is not developed since it is beyond the scope of the paper and since numerous other articles, books, and studies have dealt with the issue.

The dimensions of this interface are numerous and complex. One could engage in lengthy studies of the topic and still not deal with all aspects of it.[17] Here we deal briefly with two dimensions of the interface: (1) the type and quality of faculty effort required to foster research leading to the advancement of technology, and (2) the financing of research in universities.

Faculty Effort Directed Toward Research

The specialization of Canadian universities was discussed earlier. It was noted that 14 of Canada's 59 universities perform the vast majority of basic research in discipline areas that have an impact on technology. This specialization has little to do with the size of the institutions; instead, it derives directly from the type of faculty recruited to and sustained within the universities.

Many persons outside universities, and some within them, do not understand the research milieu. Probably no definition of research is adequate, but one may conceive of research as scholarly investigation, experimentation, and creative activity that leads to new knowledge. Research in a given field requires a highly-trained, disciplined "critical mass" of persons (sometimes as few as one person) pursuing an area in which they are keenly interested. One can have research that is accompanied by little or no teaching. Conversely, one can have teaching that is accompanied by little or no first-rate research. For the best university research environment, however, research and teaching should support one another, particularly through a program of graduate studies.

Those Canadian universities that have achieved status as major research universities have done so by making deliberate priority decisions to hire research-oriented faculty and by giving them the freedom to pursue their interests.

Developing and developed countries must squarely face this issue. If a country desires good research from its university sector, it is not sufficient to create and fund large universities. On that basis alone, a university oriented toward serving large numbers of undergraduate students (as for example, Carleton University in Ottawa, or Cleveland State University in the United States) may well emerge. It is commonly accepted that in order for a country to achieve inter-

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[17] cf. A Science Policy for Canada: Report of the Special Senate Committee on Science Policy (Ottawa, Ont.: Queen's Printer, 1972).

national leadership in basic research, applied research, and technology, a substantial amount of the nation's research must be performed in the university sector (see Appendix C for a comparison among several developed countries as to the amount of research conducted in universities and the breakdown between basic research, applied research, and development). For the research to be effective, governments and universities must ensure that the right faculty are recruited and that they are actively encouraged and supported in their research.[18]

We turn now to one element of this support that has been particularly influential in fostering research in Canadian universities: the government's policy for financing research in universities.

Financing Research in Canadian Universities

What portion of a developed country's national wealth should be spent on research and how should this be directed among the various sectors performing research--eg., government research laboratories, industry, universities, etc.?

One measure of national wealth that provides some comparability across countries is the proportion of G.N.P. per capita spent for research. The following chart contains a plot of basic research as a percent of G.N.P. vs. G.N.P. per capita for a number of developed countries. Most countries cluster around the diagonal line representing 0.1% per $1000 of G.N.P. per capita.

Canada falls below this line--i.e., spends less of its G.N.P. per capita on research than the average. As discussed in the beginning of this paper, part of the reason for this fact is that much of the R & D performed in Canada is financed by U.S. based multi-national corporations. A second reason for Canada's ranking is that it spends very little on research related to defense, which accounts for a large part of the research expenditure in some countries, eg., the United States.

However, Canada's rapid movement away from the line between 1967 and 1970 was not a result of any change in these

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[18] Aspects of this encouragement and support will vary from country to country, but two elements required in all countries are adequate time for research free from other duties and adequate scientific equipment. Table 3 in Appendic C shows the percent of time spent in research in universities of several countries.

Chart II

BASIC RESEARCH AS A PERCENT OF G.N.P. vs. G.N.P. PER CAPITA[19]

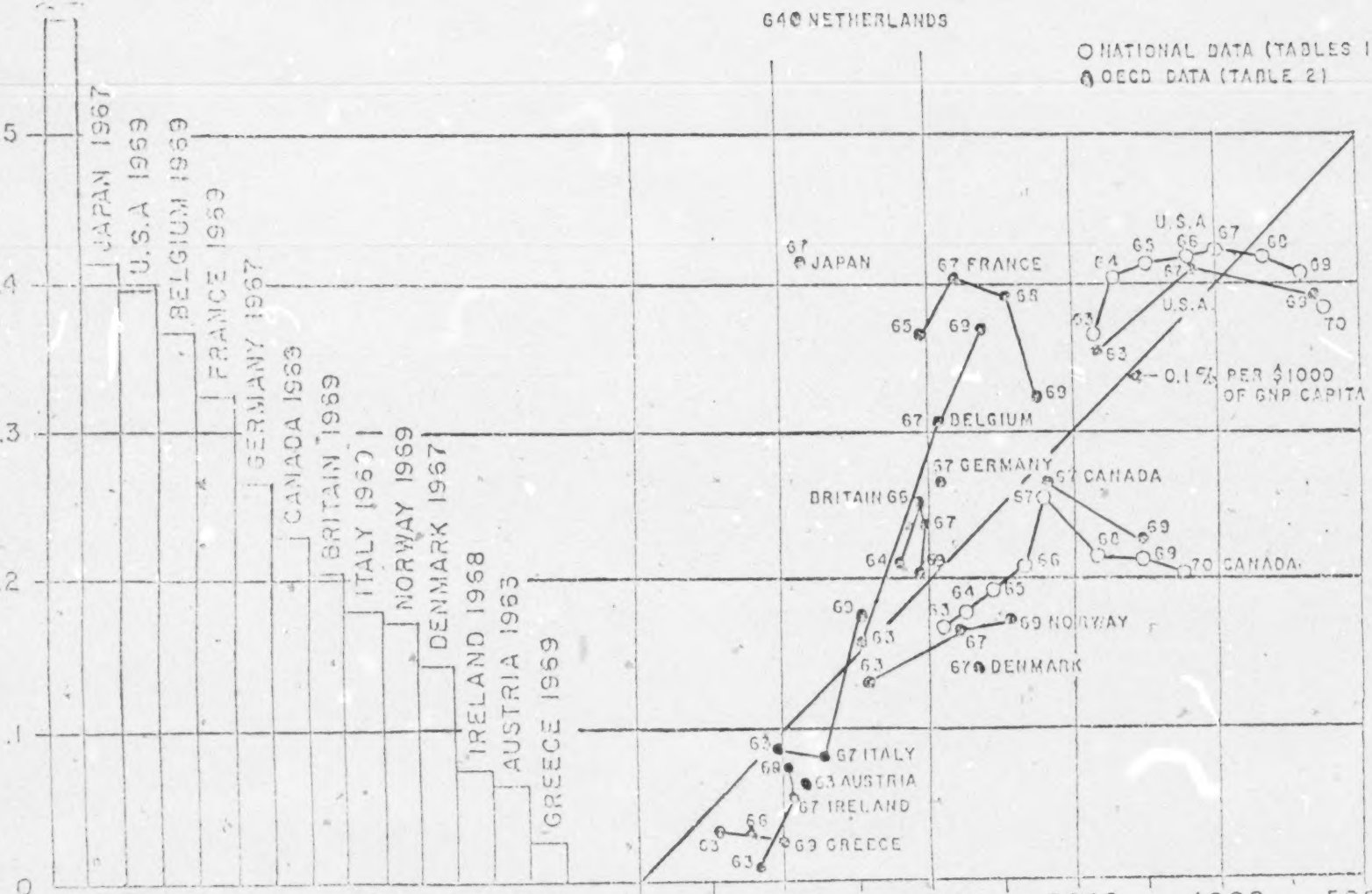

FIGURE IA

FIGURE IB

[19] A.N. Bourns, "Remarks Made by Dr. A.N. Bourns at the Hamilton Association for the Advancement of Literature, Science and Art" (Hamilton, Ontario: McMaster University, 1974), Table 5.

factors. As we have seen, foreign activity in Canada's industry (and related research and technology) has stabilized. And the country's defense effort has been relatively small for a number of years. What then caused the shift?

Part of the answer lies in the way in which university research has been financed. As Table 1 in Appendix C indicates, Canada has directed more of its R & D expenditures to the university sector than a number of other developed countries. Arrangements for the financing of this research have undergone changes over the years. However, during the past two decades federal R & D monies flowing to universities have been primarily channeled through three agencies: Canada Council, the Medical Research Council (MRC) and the National Research Council (NRC). Canada Council supports research in the humanities and social sciences, and is not directly related to our topic. MRC finances research in the health sciences and related areas. NRC finances research in the biological sciences, physical sciences, and engineering.

Attitudes about this arrangement have varied, with those within universities generally having positive regard for the Councils. Beginning in the late 1960's the Canadian government, for a number of reasons, began to reduce the real level of funding to the Councils. That is, the government froze funding and inflation eroded the purchasing power of the grants to faculty. Since such a large part of Canada's R & D expenditures are channeled through universities, the country moved rapidly away from the 0.1% line as support for the Councils declined.

As a mirror for the rest of the world to view the financing of their R & D, Canada's experience in the financing of research through universities may add perspective. Certain questions which may sharpen the focus come quickly to mind. For instance, in a country where much of the technology is dominated by foreign companies and where it is impractical to think of "buying back" the industry,[20] would it not seem more advantageous to the country to channel proportionately more of its R & D money through its universities? For all practical purposes these universities are public institutions in the full sense of the word. Even if they are staffed by a large number of non-citizens, over time many of these faculty become citizens. As the demography of the country stabilizes, it is possible to hire a greater proportion of the country's scientific "native sons".

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[20]Fayerweather, p. 32.

Another question that comes to mind is why Canada would channel proportionately more R & D money through the government labs than any other country (see Appendix C, Table 1), particularly since these expenditures are not for defense? Even the United Kingdom, which has a long history that mitigates against R & D in universities, spends proportionately less on R & D through government labs than does Canada.

Of all the performing sectors, major research universities seem least likely to be subject to pressures that would diminish world leadership in research and technology. Government agencies can easily become sidetracked by intramural competition and whimsical policy. Business and industry follow the fickle marketplace. In contrast, North American universities have been committed to advancing knowledge through research since the founding of Johns Hopkins (Baltimore Md.) in 1876. The motives of research-oriented faculty are not likely to change. By reducing the amount of R & D support for universities, Canada may be hindering one of its most positive forces for the advancement of an indigenous technology.[21]

Concluding Remarks

This paper has attempted to summarize certain aspects of technological development in Canada and the relation of these to higher education. It was prepared for a seminar on the role of institutional research in Brazilian higher education. The paper was intended to outline the main themes of the topic so that they could be compared and contrasted with experiences in other countries.

Three major topics have been discussed: the development of Canadian technology, the emergence and current status of Canadian higher education, and the interface between technological development resulting from higher education and its application in the nation.

Hopefully this material has fostered the purposes of the seminar.

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[21] University Affairs, July 1976 (Ottawa, Ont.: Association of Universities and Colleges of Canada), p. 6.

APPENDIX A

APPENDIX A
Table 1
EXPENDITURES ON EDUCATION FROM 1958
MILLIONS OF DOLLARS[22]

SOURCES OF FUNDS	1958-59	1973-74	1974-75	1975-76
Local government taxation	491.6	2,000.4	2,000.6	2,368.6
Provincial governments	521.9	5,905.1	6,456.6	7,081.4
Federal government	100.0	944.9	1,628.4	1,124.1
Private Sources	116.5	771.0	826.3	913.7
TOTAL SOURCES OF FUNDS	1,235.0	9,622.0	10,511.9	11,487.8
EXPENDITURES ON EDUCATION				
Elementary & Secondary educ.				
Public	933.9	6,207.8	6,737.1	7,278.5
Private	6.7	186.8	207.3	235.0
Teacher training outside of University	11.7	n.a.	n.a.	n.a.
Higher education	168.7	2,054.6	2,257.2	2,510.0
Other formal education	72.5	609.8	690.3	680.0
Total formal education	1,193.5	9,059.0	9 891.9	10,807.8
Vocational training	41.5	563.0	620.0	680.0
TOTAL EXPENDITURES	1,235.0	9,622.0	10,511.9	11,487.8
% OF GROSS NATIONAL PRODUCT	3.3	8.1	n.a.	n.a.

Table 2
EDUCATIONAL ENROLMENT FROM 1958[22]

TYPE OF SCHOOL OR COURSE	1958-59	1971-72	1973-74	1974-75
Elementary and Secondary				
Public and Separate Sch.	3,450,844	5,821,860	5,667,320	5,559,100
Overseas Schools	5,092	4,600	4,607	4,600
Private Schools	141,683	122,580	158,616	164,080
Indian Schools	31,353	26,780	31,686	32,710
Blind and Deaf Schools	2,340	4,075	3,772	3,805
Vocational Education				
Private Trade Schools	10,769	n.a.	n.a.	n.a.
Trade Courses, apprentices	6,358	60,618	n.a.	n.a.
Vocational High Schools	81,224	n.a.	n.a.	n.a.
Post-secondary Courses	5,857	145,580	210,850	225,080
Business Colleges	19,068	n.a.	n.a.	n.a.
Universities and Colleges	86,500	341,030	332,412	342,380
Teacher Training:				
Teacher's Colleges	15,723	5,000	n.a.	n.a.
Faculties of Education	--	n.a.	n.a.	n.a.

In the 1974-75 school year there are 14,484 publicly-controlled schools employing 255,185 teachers and there are 899 private schools employing 8,342. There also are 291 Indian schools, 76 Northern Administration schools (17,000 pupils of whom 40% are Eskimos and 20% Indians), 11 overseas schools operated by the Department of Defense.

[22] Harris, p. 92.

Table 3
UNIVERSITY ENROLMENT BY PROVINCE
FULL-TIME STUDENTS, 1974-75[23]

PROVINCE	UNDER-GRAD.	GRAD.	PROVINCE	UNDER-GRAD.	GRAD.
Alberta	26,500	3,220	Ontario	129,600	16,600
British Columbia	25,970	3,780	Prince Edward I.	1,290	--
Manitoba	15,690	1,700	Quebec	61,300	9,600
New Brunswick	10,250	480	Saskatchewan	13,040	600
Newfoundland	5,820	310	CANADA 1974-75	304,930	37,450
Nova Scotia	15,410	1,160	CANADA 1972-73	285,158	36,559

Table 4
BACHELOR'S AND FIRST PROFESSIONAL DEGREES AWARDED
BY FIELD OF SPECIALIZATION FOR CANADA[23]

FIELD OF SPECIALIZATION	1971-72	1972-73	1973-74	1974-75
Agriculture	617	608	680	690
Architecture	249	243	220	230
Arts	29,706	27,778	29,060	29,340
Science	8,788	8,916	9,260	9,300
Commerce and Business Administration	3,656	3,965	4,620	4,910
Dentistry	398	414	450	460
Education	14,665	13,744	14,350	14,480
Engineering and Applied Science	4,200	4,122	4,000	3,900
Fine and Applied Arts	498	630	820	990
Forestry	90	204	220	230
Household Science	600	529	530	530
Law	2,152	2,268	2,540	2,690
Library Science	152	96	80	80
Medicine	1,550	1,478	1,650	1,750
Music	449	448	450	460
Nursing	1,156	1,215	1,350	1,450
Rehabilitation Medicine	241	272	300	300
Pharmacy	461	549	540	530
Physical and Health Educ.	1,354	1,541	1,720	1,830
Social Work	349	484	680	840
Religion and Theology	600	508	490	480
Veterinary Medicine	138	176	180	200
Other	495	508	520	530
TOTAL	72,564	70,696	74,710	76,200

[23] Harris, p. 93.

Table 5
MASTER'S DEGREES AND EARNED DOCTORATES
BY BROAD FIELDS OF SPECIALIZATION FOR CANADA [24]

FIELD OF SPECIALIZATION	MASTER'S DEGREES				EARNED DOCTORATES			
	71-72	72-73	73-74	74-75	71-72	72-73	73-74	74-75
Agricultural and Biological Sciences	544	473	440	420	261	249	271	290
Education	1,721	1,952	2,160	2,250	109	123	132	145
Engineering and Applied Sciences	1,026	1,011	980	980	240	300	332	360
Fine and Applied Arts	97	95	100	100	6	3	5	5
Health Professions and Occupations	292	320	330	350	151	180	204	220
Humanities and Related	2,262	2,271	2,315	2,350	202	228	256	280
Mathematics and Physical Sciences	957	925	910	910	524	558	590	635
Social Sciences and Related	3,359	3,583	3,660	3,790	231	291	340	385
TOTAL	10,258	10,630	10,895	11,150	1,724	1,929	2,130	2,320

Table 6
NATIONAL INCOME AND GROSS NATIONAL PRODUCT
FROM 1956 [25]

	1956	1971	1972	1973
	(Millions of Dollars)			
Wages, salaries, and supplementary labour income	14,890	51,260	56,853	64,108
Military pay and allowances	424	908	962	1,039
Corporation profits before taxes	2,908	9,050	10,831	14,275
Rent, interest and miscellaneous investment income	1,767	3,810	4,097	5,180
Accrued net income of farm operators from farm production	1,450	1,549	1,726	3,014
Net income of non-farm unincorporated business	1,965	5,624	6,106	6,803
Inventory valuation adjustment	-238	-636	-1,008	-2,418
NATIONAL INCOME	23,166	70,583	78,693	90,755
Indirect taxes less subsidies	3,636	12,333	13,669	15,357
Capital consumption allowances and miscellaneous valuation adjustments	3,642	10,618	11,420	13,057
Residual error of estimate	141	-438	-847	g267
GROSS NATIONAL PRODUCT AT MARKET PRICES	30,585	93,094	102,935	118,902

1974 Gross National Product was $139,500,000,000, an increase of 17.3 per cent. However, real growth (after discounting the inflation factor) was only 3.7 per cent.

[24] Harris, p. 93.

[25] Harris, p. 97.

Table 7
LEADING SOURCES OF CANADA'S IMPORTS AND EXPORTS
1974[26]

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IMPORTS FROM	$,000	EXPORTS TO	$,000
United States	21,205,858	United States	20,629,481
Japan	1,423,187	Japan	2,219,206
Venezuela	1,289,414	United Kingdom	1,873,274
United Kingdom	1,127,803	Germany	527,246
Germany	764,388	Italy	457,068
Iran	616,162	China, Communist	434,148
France	395,088	Brazil	380,155
Australia	328,500	Netherlands	379,966
Saudi Arabia	318,907	Belgium & Netherlands	362,380
Italy	315,968	France	308,209
Sweden	233,604	Australia	295,681
Taiwan	193,699	Russia	290,627
Netherlands	162,403	Norway	232,239
Switzerland	136,905	Mexico	177,061
ALL COUNTRIES	31,527,377	ALL COUNTRIES	31,191,277

Table 8
LEADING IMPORT AND EXPORT COMMODITIES[27]

IMPORT COMMODITY, $,000	1974	EXPORT COMMODITY, $,000	1974
Automotive, total	6,700,759	Automotive, total	5,528,258
Parts, except engines	3,132,259	Passenger cars	2,628,408
Sedans, new	1,809,445	Parts, except engines	1,478,222
Trucks and tractors	826,566	Trucks and tractors	846,439
Engines	396,761	Engines and Parts	460,709
Engine Parts	332,719	Other vehicles	114,430
Other cars and chassis	203,009	Crude petroleum	3,408,484
Other vehicles	280,908	Wheat	2,030,768
Machinery	3,617,744	Wood pulp	1,854,888
Crude petroleum	2,642,818	Newsprint paper	1,719,871
Food and beverages	2,397,958	Other foods & beverages	1,678,462
Steel plate and sheet	470,150	Copper, ores and alloys	1,318,669
Apparel & accessories	441,196	Lumber, softwood	1,253,447
Sugar, raw	396,000	Machinery	1,147,97[illegible]
Broad woven fabrics	358,738	Nickel, ores and alloys	872,0[illegible]
Organic chemicals	355,907	Iron and steel products	732,080
Plastic, not shaped	347,307	Petroleum & coal products	593,660
Aircraft, with engines	337,175	Zinc, ores and alloys	546,019
Electronic computers	331,290	Aluminum	504,387
Chemicals, n.e.s.	287,321	Natural gas	493,640
Books, magazines and newspapers	271,593	Fertilizers	420,718
Steel, bars and rod	247,603	Aircraft, engines, parts	433,451
Fuel Oil	234,484	Asbestos	335,002
Paper and paperboard	206,744	Barley	320,252
Yarn and thread	171,627	Coal	319,108
TOTAL IMPORTS	31,527,377	TOTAL, DOMESTIC EXPORTS	31,191,277

[26] Harris, p. 98.

[27] Harris, p. 99.

Table 9
EXPORTS BY PROVINCE OF ORIGIN[28]
(in Millions of Dollars)

PROVINCE	1972	1973	1974	PROVINCE	1972	1973	1974
Alberta	1,412	1,998	4,100	Nova Scotia	330	406	560
British Columbia	3,388	4,807	5,607	Ontario	8,878	10,653	11,907
Manitoba	350	439	510	Prince Edward I.	13	17	17
New Brunswick	458	587	773	Quebec	4,212	4,961	6,264
Newfoundland	203	274	490	Saskatchewan	351	481	826
				CANADA	19,661	24,719	31,191

Table 10
LEADING MANUFACTURING CITIES
CENSUS METROPOLITAN AREAS 1970[29]

CITY	NO. OF ESTABLISH-MENTS	TOTAL EMPLOY-EES	SALARIES AND WAGES	VALUE OF SHIPMENTS
Toronto, Ont.	5,684	294,140	$2,097,134,000	$8,646,668,000
Montreal, Que.	5,243	263,313	1,694,244,000	6,890,574,000
Hamilton, Ont.	681	66,807	518,717,000	2,223,787,000
Vancouver, B.C.	1,846	62,356	466,517,000	1,905,829,000
Windsor, Ont.	374	32,365	306,807,000	1,614,303,000
Winnipeg, Man.	957	39,305	234,023,000	1,029,794,000
Kitchener, Ont.	509	42,055	271,073,000	1,017,221,000
Edmonton, Alta.	584	20,118	140,772,000	727,439,000
London, Ont.	321	19,643	138,998,000	604,524,000
Calgary, Alta.	510	14,838	104,744,000	535,652,000
Quebec, Que.	512	21,173	127,942,000	493,107,000
Ottawa, Ont.	332	17,950	131,193,000	425,654,000
Saint John, N.B.	86	6,707	42,454,000	241,093,000
Halifax, N.S.	128	6,687	41,803,000	237,610,000
Saskatoon, Sask.	162	4,083	26,676,000	161,409,000
Regina, Sask.	128	3,496	24,039,000	150,737,000
Victoria, B.C.	210	5,037	36,931,000	123,026,000
St. John's Nfld.	76	2,568	14,576,000	57,090,000

[28] Harris, p. 99.

[29] Harris, p. 102.

22.

Table 1

SELECTED COUNTRIES [30]

COUNTRY	IMPORTS 1972	IMPORTS $,000 1973	COUNTRY	EXPORTS 1972	EXPORTS $,000 1973
United Kingdom	968,467	1,003,445	Czechoslovakia	1,340,722	1,571,679
Ireland	16,707	26,445	Ireland	22,796	32,853
Austria	43,899	59,207	Belg.-Lux.-Luxech.	197,162	287,971
Belgium-Luxemb.	80,131	103,666	Denmark	18,316	22,560
Denmark	46,353	57,042	Finland	9,994	15,697
Finland	16,255	20,742	France	154,000	208,897
France	258,954	326,743	Germany West	312,600	43,041
Germany West	330,662	606,737	Greece	23,369	30,240
Greece	16,673	23,867	Italy	200,822	291,078
Italy	204,805	237,238	Netherlands	231,620	279,895
Netherlands	94,742	116,623	Norway	152,663	193,660
Norway	70,136	77,563	Portugal	17,163	19,368
Portugal	22,172	25,802	Spain	55,419	64,550
Spain	50,765	61,291	Sweden	45,182	58,092
Sweden	140,970	166,199	Switzerland	40,310	63,578
Switzerland	101,685	117,796	EASTERN EUROPE	2,845,576	3,585,041
WESTERN EUROPE	2,630,404	3,034,530	Poland	31,033	45,064
Czechoslovakia	34,196	42,793	Roumania	13,023	12,691
Hungary	11,606	13,275	USSR	284,712	290,567
Poland	21,493	29,626	Yugoslavia	25,620	36,733
Roumania	11,778	14,993	EASTERN EUROPE	378,868	418,287
USSR	15,199	22,984	Iran	22,450	53,640
EASTERN EUROPE	108,968	143,419	Israel	24,717	35,665
Emirates, UAE	27,064	50,255	Lebanon	14,006	21,255
Iran	70,381	131,676	Libya	4,634	12,872
Iraq	12,853	20,550	Saudi Arabia	6,722	13,122
Israel	16,701	22,489	Turkey	12,405	25,326
Libya	40,619	41,637	MIDDLE EAST	110,627	180,681
Saudi Arabia	54,636	60,380	Nigeria	20,920	22,742
Yemen, P.D.R.	603	23,865	South Africa	43,795	59,204
Turkey	2,812	3,809	Algeria	29,163	27,520
MIDDLE EAST	239,626	362,610	Tunisia	4,767	12,349
Mauritius-Dep.	18,129	29,387	OTHER AFRICA	165,000	186,000
Nigeria	60,778	82,158	Bangladesh	--	54,284
South Africa	58,942	86,801	Hong Kong	21,064	27,557
Angola	45,145	53,585	India	99,312	155,377
OTHER AFRICA	234,511	312,126	Malaysia	15,497	28,690
Hong Kong	104,970	109,872	Pakistan	40,671	43,067
India	44,404	38,466	Singapore	9,457	16,116
Malaysia	31,813	53,996	People R. China	263,624	287,747
Singapore	25,594	41,114	Indonesia	14,425	17,579
People R. China	48,377	52,904	Japan	959,260	1,793,457
Japan	1,071,467	1,018,262	Korea, South	32,882	61,950
Korea, South	43,728	90,564	Philippines	29,437	26,162
Philippines	11,854	18,204	Taiwan	24,476	33,668
Taiwan	126,186	163,771	Thailand	11,481	14,872
OTHER ASIA	1,533,392	1,614,089	OTHER ASIA	1,540,003	2,580,334
Australia	196,746	235,970	Australia	156,093	204,117
New Zealand	42,696	73,119	New Zealand	33,257	49,338
OCEANIA	255,570	322,310	OCEANIA	197,252	256,603
Argentina	11,679	14,459	Argentina	60,647	34,076
Brazil	61,866	87,074	Brazil	86,269	111,322
Chile	6,510	35,674	Chile	10,495	22,433
Columbia	30,418	32,639	Columbia	28,471	33,687
Ecuador	10,748	15,498	Peru	59,780	50,479
Peru	9,227	16,893	Venezuela	150,270	102,009
Surinam	5,323	7,881	SOUTH AMERICA	413,696	379,671
Uraguay	495	554	Bahamas	13,969	13,894
Venezuela	410,908	522,345	Br. Honduras	--	--
SOUTH AMERICA	565,418	751,402	Barbados	11,230	15,307
Jamaica	19,649	22,040	Jamaica	39,513	41,924
Costa Rica	10,267	12,779	Trinidad-Tobago	21,571	26,921
Cuba	11,076	16,611	Costa Rica	--	--
Honduras	19,417	16,503	Cuba	58,730	81,683
Mexico	52,952	83,282	Dominican Rep.	14,534	15,145
Neth. Antilles	34,524	47,100	Mexico	99,079	118,557
Puerto Rico	9,647	14,449	Puerto Rico	52,350	52,926
CENTRAL AMERICA	222,279	278,487	CENTRAL AMERICA	373,136	445,699
UNITED STATES	12,876,507	16,496,551	UNITED STATES	13,548,503	16,606,640
TOTAL IMPORTS	18,667,755	23,316,806	TOTAL EXPORTS	19,589,437	24,643,575

[30] Harris, p. 100.

Table 12

POPULATION AND AREA OF CANADA BY PROVINCES [31]

PROVINCE, TERRITORY	CAPITAL	AREA IN SQUARE MILES			POPULATION		
		LAND	FRESH WATER	TOTAL	1966 CENSUS	1971 CENSUS	JAN. 1975 ESTIMATE
Newfoundland	St. John's	143,045	13,140	156,185	493,396	522,105	540,000
Prince Edward Island	Charlottetown	2,184	-	2,184	108,645	111,645	115,000
Nova Scotia	Halifax	20,402	1,023	21,425	756,039	788,960	818,000
New Brunswick	Fredericton	27,385	519	28,354	616,788	634,555	670,000
Quebec	Quebec	523,860	71,000	594,860	5,780,845	6,027,765	6,165,000
Ontario	Toronto	344,092	68,490	412,582	6,960,870	7,703,110	8,171,000
Manitoba	Winnipeg	211,775	39,225	251,000	963,066	988,245	1,014,000
Saskatchewan	Regina	220,182	31,518	251,700	955,344	926,245	912,000
Alberta	Edmonton	248,800	6,485	255,285	1,463,203	1,627,870	1,747,000
British Columbia	Victoria	359,279	6,976	366,255	1,873,674	2,184,620	2,441,000
Northwest Territories	Yellow Knife	1,253,438	51,465	1,304,903	28,738	34,805	37,000
Yukon Territory	Whitehorse	205,345	1,730	207,076	1,382	18,390	20,000
TOTAL		3,560,238	291,571	3,851,809	20,014,880	21,568,315	22,659,000

Table 13

POPULATION BY MOTHER TONGUE, FOR CANADA AND PROVINCES, 1971 [31]

PROVINCE	ENGLISH	FRENCH	GERMAN	INDIAN, ESKIMO	ITALIAN	DUTCH	POLISH	UKRAINIAN	OTHER
Newfoundland	514,520	3,635	515	1,620	175	120	45	50	1,430
Prince Edward Island	103,105	7,360	140	145	35	280	40	30	510
Nova Scotia	733,560	39,330	2,000	2,710	1,495	1,850	555	435	7,020
New Brunswick	410,400	215,730	1,110	2,725	755	665	155	110	2,905
Quebec	789,185	4,867,250	31,025	21,050	135,455	4,660	15,480	11,385	152,265
Ontario	5,971,570	482,045	184,880	28,590	344,285	77,475	73,985	80,230	460,050
Manitoba	662,720	60,550	82,720	31,665	7,265	10,385	15,900	72,925	44,130
Saskatchewan	685,920	31,605	75,885	26,020	2,045	4,695	7,675	53,385	39,025
Alberta	1,263,935	46,500	92,800	29,920	15,570	20,670	13,730	70,895	73,855
British Columbia	1,807,250	38,035	89,020	18,550	31,030	23,955	7,100	20,055	149,620
Yukon	15,345	450	565	1,030	75	100	55	150	620
Northwest Territories	16,305	1,160	425	15,800	175	80	60	205	595
TOTAL	12,973,810	5,793,650	561,085	179,825	538,360	144,920	134,780	309,855	932,020

[31] Delury, p. 706.

Table 14

CANADIAN CITIES WITH METROPOLITAN[32] POPULATIONS OVER 100,000

	METRO AREA*	CITY
Montreal, Que.	2,743,208	1,214,352
Toronto, Ont.	2,628,043	712,786
Vancouver, B.C.	1,082,352	426,256
Ottawa, Ont.	602,510	302,341
Winnipeg, Man.	540,262	246,246
Hamilton, Ont.	498,523	309,173
Edmonton, Alta.	495,702	438,152
Quebec, Que.	480,502	186,088
Calgary, Alta.	403,319	403,319
St. Catherines, Ont.	303,429	109,722
London, Ont.	286,011	223,222
Windsor, Ont.	258,643	203,300
Kitchener, Ont.	226,846	111,804
Halifax, N.S.	222,637	122,035
Victoria, B.C.	195,800	61,761
Sudbury, Ont.	155,424	90,535
Regina, Sask.	140,734	139,469
Chicoutimi, Que.	133,703	33,893
St. John's, Nfld.	131,814	88,102
Saskatoon, Sask.	126,449	126,449
Oshawa, Ont.	120,318	91,587
Thunder Bay, Ont.	112,093	108,411
Saint John, N.B.	106,744	89,039

* 1971 Census Metropolitan Area

[32] Delury, p. 706.

Table 15

Expected Annual Faculty and Staff Expenditures [33]

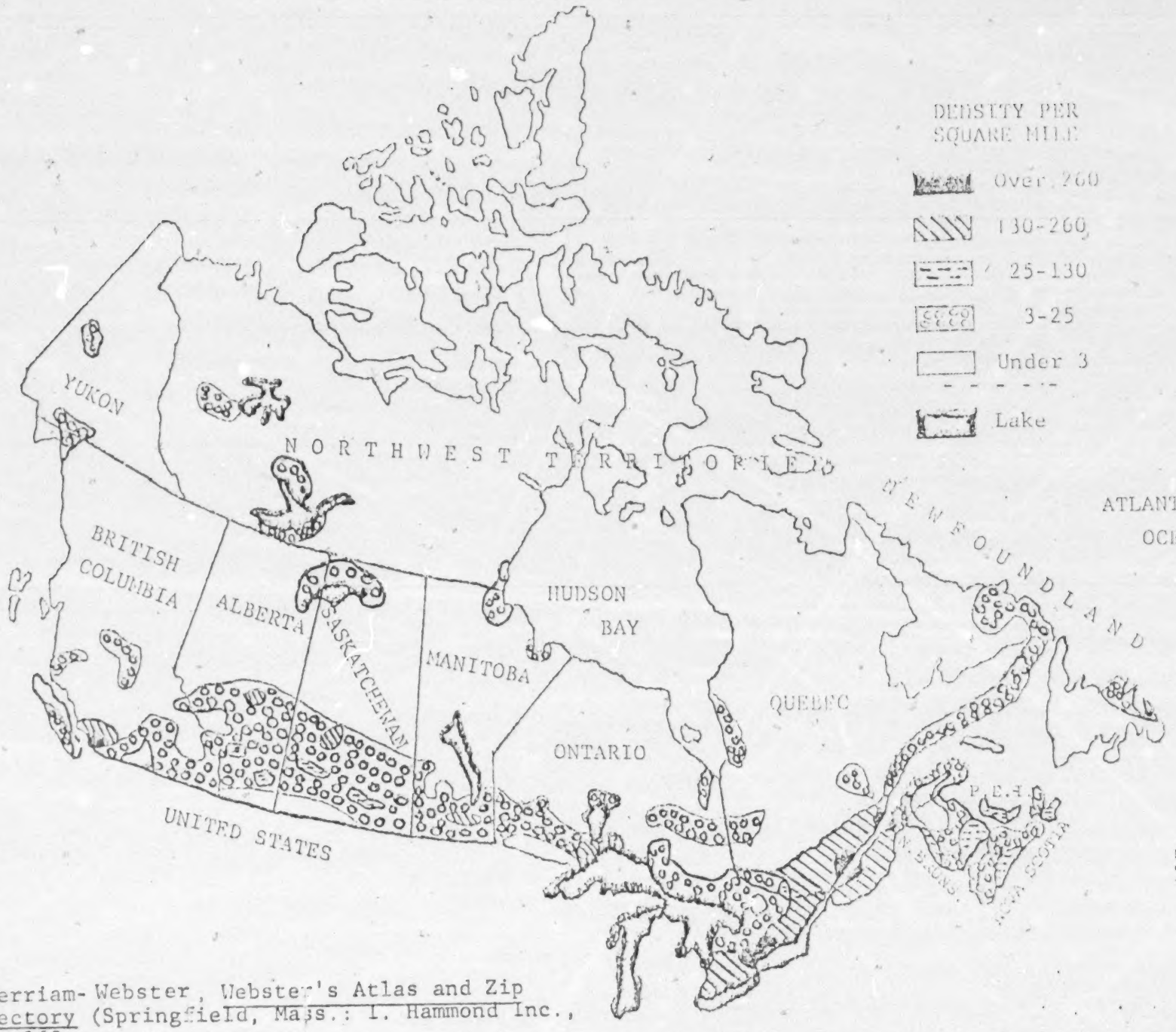
Expenditure Item	% of Total Expenditure		Expected Annual Expenditure	
Food	22.7		4,702,000	
Shelter	22.0		4,557,000	
Rented Living Quarters		6.3		1,305,000
Owned Living Quarters		11.0		2,279,000
Other Housing		.9		186,000
Water, Power and Fuel		3.8		787,000
Household Operation	5.2		1,077,000	
Furnishings & Equipment	5.6		1,160,000	
Household Appliances		1.6		331,000
Other		4.0		829,000
Clothing	9.4		1,947,000	
Personal Care	3.0		621,000	
Medical & Health Care	3.9		808,000	
Smoking & Alcoholic Bevs.	4.4		911,000	
Travel & Transportation	16.3		3,377,000	
Automobile (and Truck)		13.6		2,818,000
Purchase		5.8		1,202,000
Operation		7.8		1,616,000
Other		2.7		559,000
Recreation	4.0		829,000	
Reading	.8		166,000	
Education	.9		188,000	
Miscellaneous Expenses	1.8		373,000	
TOTAL	100.0		20,716,000	

[33] Office of Institutional Research, The Economic Impact of McMaster University on the City of Hamilton and Surrounding Localities (Hamilton, Ont.: McMaster University, 1973), p. 7.

APPENDIX B

CANADA

POPULATION DISTRIBUTION[34]



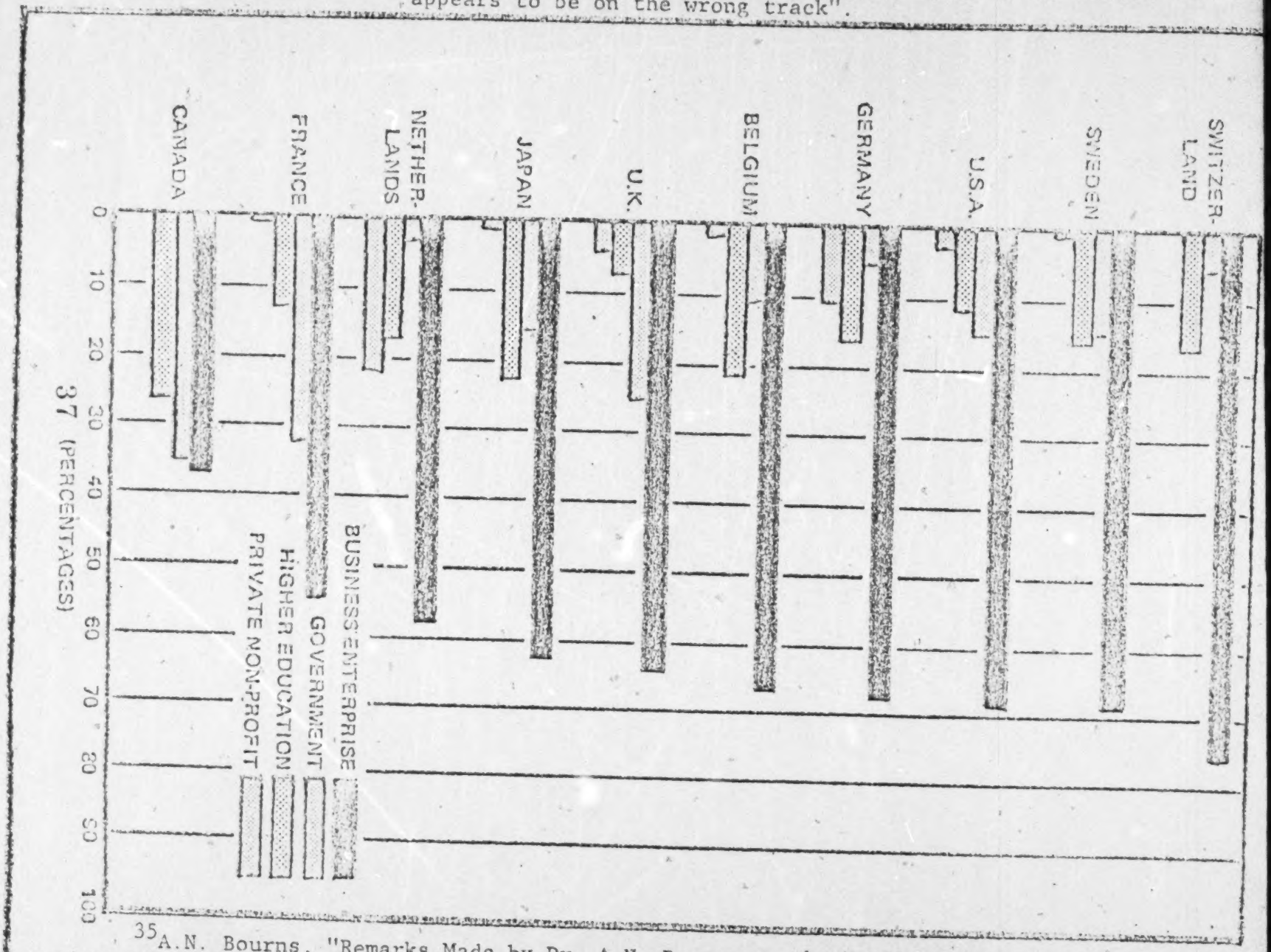
[34]A. Merriam-Webster, Webster's Atlas and Zip Code Directory (Springfield, Mass.: I. Hammond Inc., 1973), p. 163.

APPENDIX C

APPENDIX C - Table 1

TOTAL NATIONAL R&D EXPENDITURES BY SECTORS OF PERFORMANCE AND COUNTRY, IN 1967 (PERCENTAGES)

"Canada is at the bottom of the list as far as R&D performed by industry is concerned, but at the top when it comes to the government and university sectors ... Canada appears to be on the wrong track".



[35] A.N. Bourns, "Remarks Made by Dr. A.N. Bourns at the Hamilton Association for the Advancement of Literature, Science and Art" (Hamilton, Ont., McMaster Univ., 1974), Mobil...

Table 2

DISTRIBUTION OF SCIENTIFIC EFFORT BETWEEN PARTS OF THE R & D CYCLE IN FIVE COUNTRIES IN 1967 (PERCENTAGES)[36]

	Basic Research	Applied Research	Development
United Kingdom	11	24	65
United States of America	14	22	64
Belgium	21	42	37
Canada	23	38	39
Japan	27	31	42

SOURCE: Senate Committee Report, table 3, from O.E.C.D. data

[36] Bourns, Table 4.